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AIRCRAFT RESCUE TOOL OPERATIONAL TEST AND EVALUATION (OT&E)

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19. ABSTRACT (Continue on reverse if necessary and identify by block number) The objective of this effort was to develop a purchase description delineating the operating parameters of a rescue tool in performing a realistic variety of aircraft crash rescue tasks. The data collected during the extensive series of field tests indicate that there is not presently a commercial rescue tool that can completely fulfill the Air Force crash rescue requirements. The intent of this effort was to evaluate the operational performance of each tool; quantification of tool design limitations was not a part of this effort. A proposed purchase description accompanies this report.			
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PREFACE

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This technical report has been reviewed and is approved for publication.


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SECTION I INTRODUCTION

A. OBJECTIVE

The objective of this project was to perform Operational Test and Evaluation (OT&E) on commercially available and newly developed Air Force rescue tools which are state of the art, lightweight, and do not produce sparks in hazardous flammable liquid environments designated as Class I by the National Fire Protection Association (NFPA).

B. BACKGROUND

The United States Air Force (USAF) needs a rescue tool which can accomplish forcible entry into crashed aircraft to remove trapped personnel. Currently many rescue devices are used--from the simple pry axe, to gas-driven saws and hydraulically operated units. Current practice is to transport many types of rescue tools to the crash scene and individually use this equipment. This practice consumes valuable rescue time and places the firefighters in a dangerous environment for longer periods.

The function of a rescue tool is to force entry into crashed aircraft. This is accomplished by the penetrating, cutting, prying, and displacing actions of the tool.

C. SCOPE

The scope of this effort consisted of developing operational situations to evaluate serviceability, maintainability, and operability of commercially available and Air Force-developed rescue tools.

The operational characteristics which were evaluated in each rescue tool were: (1) multiple uses (cut, spread, tear, etc.), (2) puncture of aircraft for entry during crash rescue operations, and (3) operability by a single firefighter in any crash rescue scenario.

The results of these evaluations were used to prepare a purchase description incorporating the best elements of all rescue tools.

SECTION II

SELECTION OF RESCUE TOOLS

All known rescue tool manufacturers were contacted and invited to submit a tool for testing. Four companies responded to this invitation and provided their selected tool. However, one of the four companies was eliminated from consideration because its tool did not have an air over hydraulic operating capability. For the purpose of this report the companies are referred to as Company A, Company B, and Company C. Table 1 contains the specifications of each rescue tool selected for testing.

Rescue tools must be capable of operating in an aircraft crash environment where fuel vapors (NFPA Class I flammable liquids) are present without creating an explosion or fire hazard resulting from sparks, friction, or power source. To meet this requirement, only those units that operate from a hydraulic support unit and are pneumatically driven from compressed air cylinders were considered for testing. All tools evaluated in this report were operated from a standard breathing air bottle used with Self-Contained Breathing Apparatus (SCBA). Each standard breathing air bottle holds 45 ft³ at 2200 lb/in² when fully charged. Each rescue tool was tested upon the T-33 and F-100 skin and structural members, and the T-33, F-16, and F-100 aircraft cockpits.

Because of the vehicle modification necessary and the large volume of air required to drive these rescue tools, they were not tested using the Fire Fighting Vehicle Air Supply System.

The current models of rescue tools tested were not designed or modified to operate in an aircraft crash environment where fuel vapors (NFPA Class I flammable liquids) are present. Therefore, because of the known hazards involved, no testing was conducted in this type of environment. However, representatives from each of the rescue tool companies indicated that the tools can be modified or built to operate in this type of environment.

ABLE 1. RESCUE TOOL SPECIFICATIONS

	Company A	Company B	Company C
Tool Weight (pounds)	29	45	35
Hydraulic Support Unit (pounds)	30	66	78
Overall Length (inches)	34.5	32	32
Overall Width (inches)	9.5	8	8
Jaw Opening (inches)	12	15	14
Jaw Opening (seconds)	28	13	9
Jaw Closing (seconds)	23	8	7
Jaw Cutting Area (inches)	7	4	4.5
Ballistic Hose Cutting (inches)	2	4.5	3

SECTION III GENERAL DESCRIPTION OF TESTS CONDUCTED

A. TEST PLATFORM

The test platforms were actual parts and fuselages of aircraft currently in the Air Force inventory. The parts consisted of wing sections, canopies, high-pressure wire-cased ballistic hosing, and several different sections of the airframe structural members. The structural members were constructed of preformed single and multilayered aluminum alloy which ranged from 1 to 4 inches in width. The fuselages did not have wheels, wings, elevators, or a vertical stabilizer. In addition, the canopies and the pilot seats were removed for separate testing. A scaffold was used to elevate the operator to the cockpit height; however, the operability of each tool was evaluated using a standard crash rescue ladder.

B. ENVIRONMENTAL CONDITIONS

All tests were conducted on clear days during daylight. The surfaces tested were free of all liquids and the rescue tools were operated in a moisture-free environment. The average daily ambient temperature ranged between 82° and 85 °F. The area where the tests were conducted was flat and unprotected from the wind. All test surfaces had been exposed to extensive sunlight for at least 6 months. Very minor surface corrosion was on the aircraft fuselages, but no measurable reduction in member thickness.

C. TEST EVENTS

All test events, unless otherwise noted, were in accordance with the approved Air Force Test Plan (Appendix A). Each unit was tested upon the fuselage and cockpit zone of a T-33 and an F-100 aircraft. In addition, each unit was tested for its ability to penetrate and cut the canopies of T-33 and F-16 aircraft. Seven tests (Table 2) were conducted for each rescue tool: Tests 1 and 2 consisted of general evaluations on the ability to penetrate the airframe skin, cut minor structural members, and spread large openings in the skin; Test 3 evaluated the cutting capability on large structural members; Test 4 determined the ability to cut a specified size

TABLE 2. TEST EVENTS

Test Number	Type Aircraft	Description
1	T-33	Penetrate skin, cut minor structural members, spread skin
2	F-100	Penetrate skin, cut minor structural members, spread skin
3	T-33/F-100	Cut large structural members
4	T-33/F-100	Cut specified opening in aircraft body
5	T-33/F-16	Penetrate and cut canopy
6	T-33/F-100	Access flush-type panels
7	T-33/F-100	Access quarter-turn-type panels

opening; Test 5 reviewed the penetrating and cutting capability on two different canopies; and Tests 6 and 7 evaluated the effectiveness of tools in prying open various access panels.

D. TEST SETUP AND ASSESSMENT

The wings, tail sections, canopies, and cockpit seats of the T-33 and F-100 airframes were removed. To improvise a working platform which the wings would normally provide, an adjustable aircraft maintenance stand was placed alongside the aircraft fuselage. The regulated air pressure to the hydraulic pump was set at 90 lb/in² during all of the tests.

Each rescue tool was objectively assessed to quantify the number of items within each test that the unit had difficulty accomplishing. Each of these difficulties was assigned 1 point. After all seven tests were completed it was determined that accumulation of four or more points indicated a questionable performance. Rating criteria were, therefore, established in which zero points equaled excellent performance, one or two points equaled good performance, three points equaled fair performance, and four or more points equaled poor performance.

SECTION IV TESTING AND DATA

A. COMPANY A RESCUE TOOL DESCRIPTION

This rescue tool was the lightest of the tools tested. Although it was the longest, it was the best balanced and easiest to maneuver in all positions. The operating characteristics of this unit were such that the handling and ballistic hose cutting were very effective. The light weight of the unit aided maneuverability but detracted from the tool's performance; the structural components were not thick enough to support the heavy cutting operations. Although the jaw opening and closing times were relatively slow, they were acceptable for crash rescue operations. See Table 1 for tool specifications.

B. COMPANY A TEST DATA

1. Company A Test 1

The rescue tool's jaws easily penetrated the aircraft skin near the canopy by ramming action. The jaws were effective in cutting the skin sheet metal but had difficulty in spreading the 0.05-inch aluminum alloy skin. The unit had no trouble cutting minor structural members made of aluminum alloy and ranging in size from 0.25 to 2 inches.

During these test operations the high-pressure hydraulic hose from the air-driven hydraulic pump required replacement. The original hose was not constructed to support prolonged operations. In addition, the quick-connect/disconnect coupling for the hydraulic support system developed a leak due to a defective seal. The failure appeared to be caused, in part, by the type of hydraulic fluid used in the system.

In most cases, the rescue tool effectively cut all types of ballistic hose tested. However, during aircraft metal skin and rib cutting the ballistic hose cutting blade broke away from the jaw, requiring replacement. During closing operations, major deflections of the frame between 0.5 and 1.5 inches were observed on each side of the tool body.

2. Company A Test 2

Although the F-100 airframe had slightly larger structural members and thicker skin, the rescue tool yielded results similar to those in Test 1. Because the skin was thicker and more brittle, the tool ripped, rather than peeled an opening.

3. Company A Test 3

This test was conducted to determine the capability of the rescue tool to pry, spread, and cut large aircraft members. Numerous tests were performed and in each test the rescue tool's piercing tips easily crushed or spread apart the large airframe structural angles and ripped apart rivets holding the members together or to the airframe. The jaws were not capable of cutting the heavy aircraft ribs and structural frame members. Four different attempts were made to cut members ranging in size from 1 to 4 inches, without success.

4. Company A Test 4

This test demonstrated the rescue tool's capability to cut a 24-by 24-inch access hole into the aircraft body. The tool was able to penetrate and cut the aircraft skin and smaller frame members but was unable to cut or spread apart larger structural members.

5. Company A Test 5

The rescue tool easily penetrated the canopy of the T-33 aircraft. Only two thrusts with the weight of the tool were required to break and penetrate the canopy material.

Major problems were encountered while attempting to penetrate the canopy of the F-16. Numerous attempts were made using the rescue tool's tip to penetrate the canopy. All attempts failed. However, once the canopy was pried open enough to gain access to the edge, the tool was able to cut through the canopy. The cut, however, was only as wide as the cutting blades and would not allow access through the canopy material. A hole could

not be cut in the canopy because the material would not shatter; therefore, the only means of creating a hole were by repeated adjacent close cuts.

6. Company A Test 6

This test was conducted to determine the capability of the rescue tool to force open panels on the aircraft. A panel located on the right front side of the aircraft and secured by snap latches was selected for the test. The rescue tool was able to break the snap latches by spreader action. Some difficulty was encountered during the process because the surrounding aircraft skin and structural material were crushed. This prevented the panel from being easily forced open.

7. Company A Test 7

This test involved forcing open a panel secured by quarter-turn fasteners. Crushing of the surrounding aircraft material, similar to Test 6, occurred. With difficulty, the rescue tool was able to open the panel.

C. SUMMARY OF COMPANY A TESTS

Under working conditions the tool operated satisfactorily for 3 minutes before exhausting the air bottle supplies. The rescue tool proved adequate in its ability to pierce the outer skins of the T-33 and F-100 aircraft. Some difficulty was encountered in spreading sheet metal components on the F-100. Major difficulties were encountered in attempting to cut or crush large structural members; however, the tool had sufficient power to cut or crush the smaller frame members. Major deflection of the rescue tool's jaws was observed when attempting to cut or crush the larger airframe members. When deflection of the rescue tool's body occurred, the hydraulic pump would stall, indicating that maximum pump pressure was reached.

The tool easily penetrated the canopy of the T-33 aircraft and would have permitted rapid egress of aircrew members. Numerous attempts made to penetrate the canopy of an F-16 aircraft failed. The control valve used for opening and closing the tool jaws is operated manually and has three positions: open, off, and close. The valve was difficult to operate while

wearing gloves and would not return automatically to the off position when released. The hydraulic hose from the air-driven pump to the rescue tool appears to be for light duty and not suitable for extended use. The hydraulic fluid used in this system appeared to deteriorate the hose material and contribute to its failure. The fluid also caused irritation to the skin upon contact. A label on the hydraulic fluid container read "May cause irritation; avoid prolonged or repeated contact. Do not get in eyes." The quick-connect/disconnect fittings for both the air and hydraulic lines are of the same type and size. This caused some confusion and time loss when attempting to set up the system for operation. The configuration and weight of the tool, location and operation of the tool control switch, and the hose connections made handling the tool on a ladder difficult.

D. COMPANY B RESCUE TOOL DESCRIPTION

This rescue tool was very heavy and difficult to handle. The overall length was 32 inches which made the unit feel small and easy to handle; however, because most of the weight was in front of the hand grip, the slightest body imbalance while using the tool was severely aggravated. The ballistic hose-cutting design created problems during member and skin-cutting operations. The design of the hand grip provided 180 degrees of unobstructed operator movement. The on/off motorcycle-type switch was a very effective design. See Table 1 for tool specifications.

E. COMPANY B TEST DATA

1. Company B Test 1

This test was conducted to determine the capability of the rescue tool's spreader jaws to penetrate, pry, spread, and cut the aircraft skin material. Numerous tests were performed, and in each test the rescue tool's piercing tips easily penetrated the aircraft skin, using ramming action. The jaws effectively cut the sheet metal skin of the aircraft. The tool had sufficient power to spread the sheet metal, but the design of the spreader jaws made it difficult to hold the tool in place during spreading. The spreader jaws are designed so that during the curling of the sheet metal the

tool is twisted out of the operator's control. The ballistic hose cutter effectively cut all types of ballistic hoses tested.

2. Company B Test 2

This test yielded results similar to those obtained in Test 1. The test included penetrating aircraft skin and cutting structural members and ribs. The rescue tool easily accomplished all these tasks.

3. Company B Test 3

This test was designed to evaluate the tool's ability to cut or crush large structural frame members. In most cases the tool did not have sufficient power to accomplish these tasks. During normal cutting operations, one of the high-pressure hydraulic lines failed at the quick-connect coupling. The failure occurred when the threads on the coupling stripped out from high hydraulic pressure during the cutting of the canopy base plate on the F-100 aircraft. The tool successfully cut the plate where the cutting edge of the jaws made contact, but was stopped at the flat part of the jaws nearest the ballistic hose cutter.

In all cases, the spreading action of the jaws developed adequate force to crush or spread apart the airframe large structural angles and break and rip apart rivets between the skin and structural members.

4. Company B Test 4

This test demonstrated the rescue tool's capability in cutting a 24- by 24-inch access hole into the aircraft body. As in the preceding test, the tool worked well when cutting and spreading, but the flat gripping part of the jaws would grip onto a component and block the cutting action or prevent the jaws from closing completely. The test was discontinued when the tool kept catching on minor members.

5. Company B Test 5

The rescue tool easily penetrated the canopy of the T-33 aircraft. Again, major difficulties were encountered in attempting to penetrate the canopy of the F-16. Numerous attempts to use the rescue tool's tip to penetrate the canopy failed. However, once the canopy was pried up enough to gain access to an edge, the tool was able to cut through the canopy material, although not with enough force to provide a hand-access hole.

6. Company B Test 6

This test was conducted to determine the capability of the rescue tool to force open a panel on the aircraft. Another panel located on the right front side of the aircraft and secured by snap latches was selected. The rescue tool was able to break the snap latches by spreader action. The same difficulty observed for the Company A tool occurred. The surrounding aircraft skin and structural material were crushed and the panel was wedged closed.

7. Company B Test 7

This test involved forcing open a panel secured by means of quarter fasteners. Crushing of the surrounding aircraft material occurred; however, rescue tool was able to open the panel.

F. SUMMARY OF COMPANY B TESTS

Under normal working conditions, this tool operated for 3 minutes using a standard SCBA bottle. The rescue tool adequately pierced the outer skins T-33 and F-100 aircraft. During skin-cutting operations the metal would close back and the rough edges would catch in the holes of the jaw blades. This made it difficult to retrieve the tool, slowed down rescue operations, and added additional stress and strain on the operator. The ballistic hose cutter appeared to be too high and would hang or catch on components during cutting operations; however, the hose cutter successfully cut all ballistic hoses tested. Difficulties were continuously encountered in handling the tool due to its heavy weight. The design and location of the operating control valve (dead-man type) made it easy to operate.

The tool had sufficient force to cut, spread, and penetrate except where large structural members were encountered. The tool operated on both canopy types identical to the Company A tool. The hydraulic fluid used in this system was a mineral oil base; contact did not irritate the skin.

G. COMPANY C RESCUE TOOL DESCRIPTION

This tool was compact and had good balance. The handling of the tool was impaired by the restrictive hand grip which prevented the tool from being effectively utilized in more than the horizontal and vertical planes. The on/off switch was an effective motorcycle-type design; however, its use was impaired by the location of the hydraulic hoses. The cutting blades and the ballistic blades were well-placed and well-designed. See Table 1 for tool specifications.

H. COMPANY C TEST DATA

1. Company C Test 1

The rescue tool's jaws easily penetrated the aircraft skin in numerous places on the nose section of the aircraft and along the left side near the bottom of the canopy using ramming action. The jaws were effective in cutting the sheet metal skin of the aircraft. The tool had sufficient power to spread the sheet metal but the design of the spreader jaws made it difficult to hold the tool in place during spreading operations. The spreader jaws are not designed for holding and curling sheet metal during spreading operations.

2. Company C Test 2

As in Test 1 the tool could easily penetrate the aircraft skins. Some difficulties were encountered when attempting to cut or crush the minor structural frame members.

3. Company C Test 3

These tests were conducted to determine the capability of the rescue tool's spreader jaws to pry, spread, and cut the large structural aircraft members. In all cases the spreader action of the jaws developed adequate force to crush or spread apart the structural angles and break and rip apart rivets between the skin and structural members of the airframe. The cutting jaws were unable to cut large structural members.

4. Company C Test 4

This test demonstrated the rescue tool's ability to cut a 24- by 24-inch access hole into the aircraft body. As in previous tests the tool worked well when cutting and spreading, but difficulty in handling was encountered because of the tool's weight. The rescue tool, however, satisfactorily completed the opening. Although the tool cut the hole, the operation required approximately 20 minutes. This time is excessive and could be reduced if the handling balance and gripping design were modified.

5. Company C Test 5

The rescue tool easily penetrated the canopy of the T-33 aircraft. As with the other tools, major problems were encountered in attempting to penetrate the canopy of the F-16. All attempts to penetrate the canopy with the tool's tip failed. The tool could cut the canopy material but could not create a hole large enough to allow hand access.

6. Company C Test 6

This test was conducted to determine the capability of the rescue tool to force open a panel on the aircraft. A panel located on the left front side of the aircraft and secured by snap latches was selected for the test. The rescue tool was able to break the snap latches by spreader action; however, it could not pry open the panel because the size of the jaw tips were too large.

7. Company C Test 7

This test involved forcing open a panel secured by quarter-turn fasteners. Crushing of the surrounding aircraft material was encountered; however, the rescue tool was able to open the panel, although with some difficulty.

I. SUMMARY OF COMPANY C TESTS

Under normal working conditions, this tool operated for 3 minutes, using a standard, fully charged SCBA bottle and could adequately pierce the outer skins of T-33 and F-100 aircraft. The ballistic hose cutter was well-designed and effectively cut all types of ballistic hoses tested. In all cases the tool had sufficient power to cut or crush minor structural members. However, the tool's power was not sufficient to cut completely through major structural members. The tool's operation on the two canopy types was very similar to results obtained for Company A and B tools. The hydraulic fluid used in this system is a mineral oil base and was nonirritating to the skin. The rescue tool's control valve for opening and closing the cutting jaws is a dead-man type. Its design made it relatively easy to operate. The quick-connect/disconnect fittings for the air and hydraulic lines are the same type and size, which caused some confusion and delays when attempting to set up the system for operation.

SECTION V

CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

Of the four tools submitted only three were selected for testing. One manufacturer could not operate his rescue tool with compressed air. None of the tools tested had design characteristics which would allow the tool to operate in a Class I flammable environment. Because each tool's design indicated a high probability that sparks would be produced by components of the tool system, thereby endangering the operator, they were not tested in this environment. Each tool displayed positive and negative aspects of operability and maintainability as related to the desired Air Force operating characteristics (Table 3). No tool could perform all of the Air Force's requirements without some modification. Each tool's performance decreased as the pressure level of the supplied air decreased. These limitations varied with each manufacturer's cutting design. The testing conducted during this effort provided valuable information toward quantifying the design requirements of a tool that could meet the Air Force's aircraft crash rescue requirements.

B. RECOMMENDATIONS

A review of the operation of three different rescue tools and a comparison of structural material technology with the Air Force's rescue tool requirements showed that certain operating requirements cannot be met without considerably more research. A production air over hydraulic rescue tool, weighing 30 to 35 total pounds and exerting 12,000 pounds of force for 1 hour of continuous operation, is not presently available. The purchase description (Appendix B) requires these operating characteristics because they provide the most efficient and safe means of accomplishing the mission. The most cost-effective process in acquiring an operational tool which will fulfill the Air Force's crash rescue requirements is through the development and manufacturing capabilities of the competitive procurement process. The initial production models acquired from the purchase description should undergo a thorough evaluation of component construction and of system operational performance. Through this procurement process, the Air Force can ensure the purchase of an optimum rescue tool.

TABLE 3. QUALITATIVE TEST ASSESSMENT

Test	Company A	Company B	Company C
1	poor	good	good
2	poor	good	fair
3	poor	fair	fair
4	fair	poor	good
^a 5	fair	fair	fair
6	fair	fair	fair
7	good	good	good

^aEach rescue tool had difficulty with the F-16 canopy.

APPENDIX A
TEST PLAN

The material contained in this appendix is published in the decimal format because of stylistic requirements of Air Force directives.

1.0 INTRODUCTION

1.1 OBJECTIVE--To perform Operational Test and Evaluation newly developed rescue tools which:

- a. are state of the art,
- b. weigh less than 35 pounds, and
- c. do not produce sparks in hazardous NFPA Class I flammable liquid environments.

1.2 SCOPE--This effort shall develop operational situation evaluate:

1.2.1 Serviceability

1.2.2 Maintainability

1.2.3 Operability--tools must:

- a. be multiuse,
- b. cut,
- c. spread, or
- d. puncture aircraft for entry during crash rescue operations, and
- e. be operable by a single firefighter in any crash rescue scenario.

1.2.4 Test results will be used to prepare a purchase specification incorporating the best elements from all tests.

1.3 BACKGROUND

1.3.1 The USAF requires a rescue tool to accomplish forcible entry into crashed aircraft. Currently many rescue devices are used--from simple pry axe to gas-driven saws and hydraulically operated units.

1.3.2 Current practice is to transport many types of rescue tools to the crash scene and individually use this equipment. This practice consumes valuable rescue time and places firefighters in a dangerous environment for longer periods.

1.3.3 The principal tool functions in rescue operations are displacing or pushing apart and cutting. Displacing functions include forced spreading to enlarge openings in panel surfaces and cutting objects apart. Therefore the main objective of the rescue tool is to improve removal of entrapped personnel from crashed aircraft.

1.3.4 The USAF needs to perform OT&E on newly developed rescue tools to ensure performance before fielding.

2.0 DESCRIPTION OF TESTS

2.1 TEST UNITS--The rescue tools to be tested are the Air Force-designed commercial fire rescue tools. Each tool will be tested against the same test criteria. Test results will be recorded, quantified, and compared to optimal tool operation. Minor modifications may be made to certain tools to evaluate effectiveness.

2.2 TEST FACILITY--Testing will be at Tyndall Air Force Base, Florida.

2.3 INSTRUMENTATION AND PHOTOGRAPHY--Each test will have still and video photographic coverage. Video coverage will be normal speed VCR and will be synchronized with other data collection. Still photography will be color slides and black and white negatives to document the pretest setup and posttest rescue results of the tool operation.

2.4 PRETEST PROCEDURES--Test series preparation is as follows:

- a. acquire various aircraft components,
- b. install components in test platforms,
- c. position video cameras,
- d. take pretest still photographs,
- e. time measure each event, i.e., rib cutting, etc.,

- f. evacuate nonessential personnel, and
- g. conduct final camera and instrumentation checks.

2.5 POSTTEST PROCEDURES--After each test, the following actions shall be taken:

- a. inspect each rescue tool and equipment for damage,
- b. take still damage photographs before test site is disturbed, and
- c. check instrumentation readings, as applicable.

2.6 TESTING

2.6.1 An aircraft fuselage and test platform, using various aircraft components, will be used. The following test will be conducted for each rescue tool tested (as applicable).

2.6.1.1 The gasoline-driven support system will be tested for:

2.6.1.1.1 Serviceability

- a. Ensure starting ease and reliability.
- b. Check oil level--add oil if required.
- c. Check fuel level--fill tank when required.
- d. Check filter operation.
- e. Check security of connections.

2.6.1.1.2 Maintainability

- a. Remove, service, or replace engine air filter.
- b. Remove, clean, or replace spark plug; set gap as required.
- c. Test unit for proper operation.
- d. Quantify items which are replaced (based upon mean time between item failure).

2.6.1.2 Each rescue tool will be tested for operation using the Fire Fighting Vehicles Air Supply System to operate the rescue tool. A quick-connect/disconnect coupling will be installed on the vehicle to connect the

tool to the vehicle air supply system (primary vehicles for consideration are the P-4 and P-19). These tests will include the operational capability test listed in 2.6.2 of this test plan.

2.6.1.2.1 Hydraulic Support System Serviceability

- a. Ensure operational ease and reliability.
- b. Check hydraulic fluid level--add fluid if required.
- c. Check hydraulic lines and unit component parts for leaks and repair if required.
- d. Check hydraulic base connections for excessive wear and replace if required.

2.6.1.2.2 System Operation

- a. Each unit will be started and operated at least six times. During testing each unit will be operated under actual or simulated working conditions for at least 15 minutes.
- b. Evaluators will test each rescue tool while using the standard Self-Contained Breathing Apparatus (SCBA), air supply bottle, and high-pressure air bottle mounted on the rescue vehicle. These tests will include operational capability elements listed at 2.6.2 in this plan.

2.6.2 Testing the Rescue Tool

2.6.2.1 Testing each tool under actual or simulated rescue conditions will assure the tool's ability to operate in an aircraft crash environment without creating an explosion or fire hazard caused by sparks, friction, or a power source. Conduct testing after the entire area is saturated with Aqueous Film-Forming Foam (AFFF) using the same application procedures used in actual aircraft accidents where aircraft fuel spills are present. Aircraft skin, members, and ballistic hose will be cut. During simulated rescue operations the fuel type, quantity, and test duration will be determined by the Fire Chief and Test Director at the test site.

2.6.2.2 Each rescue tool will be tested under actual or simulated conditions to ensure that the tool can function effectively in the fighter and bomber cockpits to free trapped aircrew members.

2.6.2.3 Each rescue tool will be tested to ensure that it effectively opens aircraft skins, ribs, and other components necessary for ingress/egress operations. An aircraft fuselage and test platform using actual aircraft components will be used to conduct these tests.

2.6.2.4 Each rescue tool will be tested to ensure that it effectively cuts aircraft ballistic hoses, especially those behind the pilot and co-pilot seats.

2.6.2.5 Each rescue tool will be operated under actual or simulated operational conditions for 1 hour at 100 percent power to ensure operational reliability.

2.6.2.6 Each rescue tool will be tested to ensure that it exerts 12,000 pounds of force through the complete jaw opening of 12 inches. This will be accomplished using, for example, mechanical and/or hydraulic strain gages to achieve and record the actual pressures produced by the tool.

2.6.2.7 Rescue tool jaw points will be tested to ensure that they are hardened enough to prevent damage during manual piercing operations. Tests will be accomplished using the tool on an aircraft fuselage and aircraft component parts to ensure tool piercing capability during emergency operations.

2.6.2.8 Each rescue tool will be tested to ensure that it has sufficient force to effectively accomplish gripping, closing, and scissors actions in various aircraft rescue operations without losing its hold. Tests will be accomplished using an Aircraft fuselage and component parts such as ballistic hoses to ensure that the rescue tool will perform satisfactorily during actual rescue operations.

3.0 RESPONSIBILITIES--The Test Director is responsible for the test program. In addition, he or she will be responsible for test event.

countdown coordination and procedures, as well as any safety and security precautions. The Test Director will delegate authority as necessary. Specific responsibilities relative to safety are contained in the safety section.

4.0 SAFETY

4.1 PURPOSE--This safety plan establishes the safety areas for the testing site, all related functions, and identifies the agency responsible for each of these areas. All references to the test throughout this safety plan pertain to tests to be conducted at Tyndall Air Force Base, Florida. Before any fire testing can be conducted at Tyndall Air Force Base, the Base Fire Chief must be notified. The following safety documents are applicable to this test:

- a. AFOSH Standards
- b. AFR 127-4

4.2 OVERALL SAFETY RESPONSIBILITY--HQ AFESC/RDCF, as Test Director, is responsible for enforcing the overall safety program for the test. The Base Fire Chief or his designated representative will act as the safety officer during all actual fire tests. The Test Director is the safety officer for all other events at the test site. The Test Director will maintain close coordination with the Air Defense Weapons Center Ground Safety Officer on all safety matters.

4.3 SAFETY AREAS--The safety requirements of the test have been divided into three separate and distinct areas to facilitate the establishment of specific requirements. The areas of safety requirements are

- a. general safety,
- b. construction safety, and
- c. fire safety.

4.4 GENERAL SAFETY--The responsibility for general site safety resides with AFESC. The authority to execute specific safety directives is delegated to the Test Director. The Public Affairs Office (HQ AFESC/PA) is responsible for notification and publicizing the test (when applicable).

4.4.1 Safety Briefing--The Test Director will brief all AFESC personnel and/or supervisors of construction crews on the safety hazards existing within the test site. Supervisors will, in turn, brief their personnel on these hazards.

4.4.2 Visitors--Visitors shall not be allowed at the test site without approval of the Test Director or his authorized delegates. Visitors will be instructed on applicable safety regulations.

4.4.3 Individual Safety Responsibility--Careful attention to potential hazards involved in work dealing with fire must be stressed in all levels of responsibility. The purpose of the safety rules outlined here is to present the most important elements in setting controlled fires. These rules do not cover all the possible hazards or safety precautions necessary at the site. As new problems arise, new safety measures will be established to cope with them. In the interim, common sense must be applied to ensure that safety prevails. This entire safety plan must be closely followed by all personnel and enforced by all supervisors. The procedures contained here shall be accepted as minimum standards unless the Test Director, with the concurrence of the AFESC Safety Officer, authorizes deviation.

4.4.4 Vehicles--Speeds shall not exceed 20 mi/h when driving on unpaved roads. Seat belts will be used at all times while vehicles are in motion. When a vehicle is parked, the hand brake will be set and the transmission put in park or reverse.

4.4.5 Accident Reporting (Emergency)

4.4.5.1 Scope--This standard procedure is intended as a guide to ensure expedient handling and care of personnel injured in an accident or disaster. All postemergency reporting and investigation of an accident will be performed in accordance with applicable Air Force regulations and is not considered to be within the scope of this standard procedures.

4.4.5.2 Responsibility--Every person involved in this program must be completely familiar with the emergency reporting procedures established

by this plan and must implement these procedures immediately in the event of an accident. The Test Director must familiarize all supervisors with this standard procedure. The supervisor must familiarize subordinate personnel with the procedures established by this plan.

4.4.5.3 Emergency Reporting Procedures--In the event of an accident at the test site, the following procedures will be followed:

4.4.5.3.1 The senior supervisor at the scene of an accident will direct appropriate first aid. Caution will be exercised to prevent aggravation of an accident-related injury.

4.4.5.3.2 Tyndall AFB Hospital Ambulance Service will be immediately notified by calling Extension 2333. The nature of the accident, including apparent condition of injured personnel and the location of the test site, will be reported to the medical personnel. The Test Director or, in his absence, the Senior Supervisor, shall determine whether to attempt transfer of the injured to a hospital or to request emergency ambulance support.

4.4.5.3.3 The Test Director or, in his absence, the Senior Supervisor, shall determine the seriousness of the accident. If the accident is not serious enough to require emergency hospitalization or ambulance service, the injured person will be taken to a doctor or hospital by normal means of transportation.

4.4.5.3.4 First Aid--An adequate supply of first-aid items will be maintained at the site. These items will be properly stored and periodically inspected to ensure their utility in case of an emergency.

4.4.5.3.5 Fire Prevention Reporting and Emergency Procedures--This paragraph defines the responsibility for fire prevention and reporting procedures related to testing.

a. Responsibility--The Test Director will be responsible for the implementation of the procedures established by this plan. All on-site personnel must be completely familiar with these procedures to ensure proper response to an emergency.

b. Fire Prevention Procedures--The procedures listed below are to be followed in an effort to reduce chances of an uncontrolled fire.

- Three portable fire extinguishers will be at the test site.
- The Test Director shall instruct all personnel on the procedures to follow in case of fire, and the location and use of available fire extinguishers.

APPENDIX B

PURCHASE DESCRIPTION FOR TOOL SYSTEM-- RESCUE, AIRCRAFT, PNEUMATIC/HYDRAULIC

The material contained in this appendix is published in the decimal format because of stylistic requirements of Air Force directives.

1.0 SCOPE

1.1 SCOPE GENERAL

1.1.1 This purchase description covers the details of an aircraft accident rescue tool system and the components needed for operation.

1.2 SCOPE SYSTEM COMPONENTS

1.2.1 System components are the following:

- a. Lightweight multipurpose hydraulically operated tool (penetrating, spreading, cutting).
- b. Hydraulic supply unit driven from standard compressed air cylinders (45-ft³ capacity each).
- c. One-hundred-foot reach of hydraulic hose.
- d. Total compressed air supply furnished from three "two-paks" of standard air cylinders (45-ft³ capacity each).
- e. Backup hand pump.

1.3 SCOPE DESIGN REQUIREMENTS

1.3.1 System design requirements are the following:

- a. System and components to be designed for a temperature environment of -65 to +140 °F.
- b. System and components to be designed for use with hydraulic fluid, Military Specification MIL-H-5606E.
- c. All components designed for portability by rescue personnel.

2.0 APPLICABLE DOCUMENTS

2.1 The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated the issue in effect on date of invitation for bids or request for proposal shall apply.

2.1.1 Military Specifications

- MIL-H-5606E--Hydraulic fluid, Petroleum base, Ultra-low Temperature

2.1.2 Military Standards

- MIL-STD-105--Sampling Procedures and Tables for Inspection by Attributes
- MIL-STD-129--Marking for Shipment and Storage
- MIL-STD-130--Identification Marking of U.S. Military Property
- MIL-STD-810C--Environmental Test Methods
- MIL-STD-1472C--Human Engineering Design Criteria for Military System, Equipment and Facilities
- MIL-STD-1516A--Unified Code for Coatings and Finishes for DOD Material

Copies of Military Specifications and Standards required by suppliers in connection with specific procurement functions can be obtained from the procuring activity or as directed by the contracting officer.

3.0 PREPRODUCTION ARTICLE(S)

3.1 The supplier will furnish, within the time period specified, two rescue tool systems to demonstrate that his production methods and choice of design criteria will produce a rescue tool system which complies with the requirements of this purchase description. Examination and test of components and system shall be those specified herein. Any changes or deviations subsequent to the tested preproduction model shall be subject to the approval of the contracting agency, and shall not relieve the supplier of his contractual obligation to furnish rescue tool systems conforming to the details of this purchase description, or the accepted standard of quality provided in the first-article test.

3.2 RESCUE TOOL SYSTEM COMPONENTS

3.2.1 Lightweight Rescue Tool

The principal functions of rescue tools in aircraft crash operations are to penetrate, displace, push apart, and cut aircraft skins, structural members, doors, latches, and canopies. Displacing functions include forced spreading (to enlarge openings in panel surfaces) and cutting objects. The tool shall:

3.2.1.1 Be capable of operating in an aircraft crash environment where fuel vapors (NFPA Class I flammable liquids) are present without creating an explosion or fire hazard resulting from sparks, friction, or power source.

3.2.1.2 Have a total maximum weight not to exceed 35 pounds. Overall dimensions shall not exceed 36 inches in length nor more than 9 inches in width when tool is in the closed position.

3.2.1.3 Function effectively in the confined space of an Air Force fighter-and/or bomber-type cockpit to free trapped aircrew members.

3.2.1.4 Open aircraft for ingress/egress by forcing hatches, canopies, and doors.

3.2.1.5 Open aircraft for ingress/egress by cutting skin, ribs, and other aircraft components necessary to gain entry.

3.2.1.6 Cut ballistic hoses on all types of aircraft egress systems.

3.2.1.7 Be capable of continuous operation at 100 percent power for a minimum period of 60 minutes uninterrupted.

3.2.1.8 Be pneumatically powered, hydraulically operated, and capable of exerting 12,000 pounds of force through a minimum spread of 12 inches at the spreader tips. The cutters shall open a maximum of 8 inches and produce a minimum of 60,000 pounds of cutting force in the innermost part of the cutter. In addition:

3.2.1.9 The tool will have a hardened point to facilitate manual piercing to gain a point of contact for the spreader and cutter.

3.2.1.10 The tool will have gripping teeth on the working edge and a power-close capability for pull-action displacement and for scissor-type shearing.

3.2.1.11 The operator must be provided with a compact, lightweight, easy-to-handle tool. The carrying handle will permit 180 degrees ease of operation. The requirement that both hands of the operator be used to operate control valve(s) is unacceptable. Easy access to the control valve(s) shall make it possible for the operator to use either the right or left hand. Because this tool will be used to free trapped personnel, the operation of the system must be smooth and precise. The controls and handling provisions must be physically located to enhance the effectiveness of the tool. The final configuration shall be the optimum combination of the aforementioned requirements. The tool shall have dead-man control characteristics, with the valve spring loaded in such a way as to allow the control valve to return to the stop position when the control valve is released. The control valve shall utilize a check valve to provide no loss of pressure, even with the pump not operating.

3.2.1.12 The hydraulic spreader/cutter tool shall be provided with spreading tips that have an angular shape to allow easy insertion. Their

outer shape and surface texture shall provide optimum biting or grabbing characteristics. In addition to the textured surface of the tip, there shall be an area in the tip designed to curl cut metals. The outer area of each cutter shall have a beveled cutting edge extending from the base of the spreader tips along the remaining part of the cutter. Incorporated into the tip shall be a cutting device. This cutting device must be capable of cutting ballistic hose, cables, hoses, wires, steel tubing, etc. The cutting force in this cutter shall be a minimum of 60,000 pounds of cutting force in the innermost part of the cutter. This cutter shall be designed to reach into confined spaces and to sever necessary cables, hoses, wires, steel tubing, etc., without binding or causing excessive torque force.

3.2.2 Hydraulic Supply Unit

The lightweight multipurpose tool will be powered by a pneumatically driven hydraulic supply unit. The hydraulic unit will be a tubular frame mounted with carrying handles, suitable for transport by one or two rescue personnel. Pressure regulator valves, relief valves, control valves, hose connections, and other necessary hardware are to be included with the hydraulic unit. Total weight of the component shall not exceed 35 pounds. Overall dimensions shall not exceed 15 inches in width, 30 inches in length, and 18 inches in depth.

3.2.3 Hydraulic Supply Hoses

The multipurpose tool and hydraulic supply unit, when placed in service, will be connected with a 100-foot reach of hydraulic hose (100-foot supply hose and 100-foot return hose). The supply and return hoses will be tied together and coiled to facilitate storage, handling, and transport. Hoses will have matching, noninterchangeable quick-connect/disconnect fittings.

3.2.4 Compressed Air Supply

The compressed air supply will be furnished from six standard air cylinders (45-ft³ capacity, 2200 lb/in²g). Two cylinders each shall be mounted securely in a tubular framework with carrying handles suitable for

transport by one rescue person. A total of three "two-paks" (two cylinders each) are required. Weight of the compressed air supply "two-pak" component shall not exceed 40 pounds.

When any two "two-pak" component is used to power the hydraulic supply unit component, the two components will be securely attached together to prevent rupture of the connecting air lines(s).

Overall dimensions of the compressed air "two-pak" component shall not exceed 12 inches in width, 30 inches in length, and 18 inches in depth.

3.2.5 Backup Hand Pump

A backup hand pump shall be supplied with the rescue tool system to supply hydraulic fluid power. The backup hand pump shall consist of a base plate; a hydraulic fluid reservoir sufficient to independently operate the rescue tool system; a hydraulic piston pump manually activated; hose connections configured with quick-connect/disconnect, matching, non-interchangeable fittings for connecting the pump to the rescue tool; and a carrying handle. The backup hand pump shall require operation by only one rescue person. Maximum dimensions shall not exceed 12 inches wide, 24 inches long, and 9 inches in depth.

3.3 DESIGN AND MANUFACTURING

The rescue tool system shall be designed and manufactured to permit ease of operation, inspection, repair, maintenance, and storage. All components of the rescue tool system will be designed to permit assembly of equipment and operation by rescue personnel wearing heavy gloves or arctic mittens.

The hydraulic supply unit and air cylinder "two-paks" tubular frameworks will be designed for shoulder carrying as well as arm/hand carrying.

The hydraulic supply unit and air cylinder "two-paks" will be provided with antislip bottom surfaces that will not easily slide on a smooth aluminum surface at a 50 percent grade.

3.3.1 All components in the hydraulic circuitry of the rescue tool system (multipurpose tool, hoses, hydraulic supply unit, and backup hand pump) will be configured with quick-connect/disconnect matching, non-interchangeable fittings. In addition, each component shall be configured with short hose connections, or by any other suitable method, to provide containment of the hydraulic fluid in the component when it is disconnected from the hydraulic circuitry.

3.3.2 Each rescue tool system will be provided with a metal container designed for handling and storage of the rescue tool system when not in use.

3.4 MATERIALS OF CONSTRUCTION

Materials of construction for the components of the rescue tool system will be selected on the basis of weight, cold temperature ductility, functional service, corrosion-resistance, environmental factors, hydraulic fluid compatibility, and service factor. All alloy carbon steel parts will be provided with corrosion-resistant plating protection in accordance with MIL-STD-1516A. Where plating protection is not practical, a protective grease coating will be specified.

3.5 HUMAN ENGINEERING

Human engineering design criteria and principles shall be applied in accordance with MIL-STD-1472C to achieve effective integration of personnel into the design of the system. The human engineering effort shall develop or improve the crew-equipment/software interface during operation or maintenance and make effective, economical demand upon personnel resources, skills, training, and costs. Paragraphs 5.9.11.3.1 through 5.9.11.3.9 of MIL-STD-1472C are specifically referenced as a guide. Rescue personnel are burdened with protective clothing and protective devices which reduce mobility and induce fatigue.

3.6 DURABILITY

The rescue tool system shall perform as required after to the following environmental tests:

3.6.1 High Temperature

- According to Method 501.1, Procedure II, MIL-STD-810C.

3.6.2 Temperature Shock

- According to Method 503.1, MIL-STD-810C.

3.6.3 Rain

- According to Method 506.1, Procedure II, MIL-STD-810C.

3.6.4 Humidity

- According to Method 507.1, Procedure V, MIL-STD-810C.

3.6.5 Explosive Atmosphere

- According to Method 511.1, Procedure 1, MIL-STD-810C.

3.6.6 Vibration

- According to Method 514.2, Procedure X, MIL-STD-810C.

3.7 IDENTIFICATION AND MARKING

The contractor shall provide identification and marking items of the rescue tool system in accordance with MIL-STD-130.

3.8 WORKMANSHIP

The rescue tool system shall be manufactured in accordance with the specifications and standards stated in this document and to accept commercial manufacturing practices.

3.9 ACCEPTANCE TEST

Each rescue tool system shall be subjected to an operational acceptance test. The procedure for this test shall be prepared by the contractor and approved by the contracting officer prior to delivery of production units.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 RESPONSIBILITY FOR INSPECTION

Unless otherwise included in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed requirements.

4.2 CLASSIFICATION OF INSPECTION

- Preproduction Inspection (see 4.3)
- Acceptance Inspection (see 4.6)

4.3 PREPRODUCTION INSPECTION

Two test articles of the rescue tool system shall be examined tested as specified in 3.6 and 4.7. Presence of one or more defects shall be cause for rejection.

4.4 LOT

A lot for inspection purposes shall consist of all rescue systems submitted for inspection at the same time and place.

4.5 SAMPLING

Sampling, for acceptance purposes, shall be in accordance inspection level S-2 of MIL-STD-105, with an Acceptance Quality Level (AQL) of 4.0 percent.

4.6 ACCEPTANCE INSPECTION

Each rescue tool system shall be examined as specified and 4.6.2. Presence of one or more defects shall be cause for rejection.

4.6.1 Examination

Each rescue tool shall be examined for the following or defects including:

- Missing Parts
- Nonconformance to approved drawings
- Nonspecified materials of construction
- Damaged components or parts
- Noncompliance with purchase description
- Void areas of primer, paint, plating, and coatings

4.6.2 Operation

Each rescue tool system shall be functionally operated period of 60 minutes, uninterrupted, to ensure proper assembly and performance.

4.7 PREPRODUCTION TESTS

Two rescue tool systems shall be tested at the Air Force Engineering and Services Center, Tyndall Air Force Base, Florida, as follows:

4.7.1 Demonstrate the capability of the rescue tool by cutting a 24- by 24-inch access hole into the body of an aircraft. The aircraft type and location of the hole will be determined by the test director. The aircraft used for testing the rescue tool will be provided by the Air Force.

4.7.2 Demonstrate capability of being operated in a simulated crash rescue mission for a period of 60 minutes uninterrupted.

4.7.3 Demonstrate simplicity of maintenance and storage in rescue truck.

4.7.4 Demonstrate capability of rescue tool to perform operational after completion of the environmental tests.

4.7.5 Demonstrate capability of being operated in a simulated crash rescue mission for an uninterrupted period of 15 minutes using the backup handpump.

5.0 PREPARATION FOR DELIVERY

5.1 PACKAGING AND PACKING

Each rescue tool system shall be packaged in individual containers to afford adequate protection against damage during shipment from the supplier to the destination (see 6.2). Containers and packing shall comply with uniform freight classification for National Motor Freight Classification.

5.2 MARKING

In addition to any other markings required by the order contract (see 6.2), the interior package and exterior shipping container shall be marked in accordance with MIL-STD-129, as applicable.

6.0 NOTES

6.1 INTENDED USE

Since this system is to be operated primarily by rescue personnel in emergency situations, the weight and ease of handling of the rescue and other components are major considerations. The normal airfield operation envisions a rescue truck staffed with several people following major crash fire units to gain an appropriate position within the area downed aircraft. The rescue vehicle will store the rescue tool system.

6.2 CONTRACT DATA REQUIREMENTS

Any data item to be delivered under the contract must be specifically called for in the contract in accordance with the applicable regulation of the procuring activity (form DD 1423).